

Leo,

I have reviewed the memo that you provided and the results are indeed encouraging. The only problem that I see as of now is the under-estimation of the carbon beginning in May 1996. As you point out, the lack of agreement is likely due to the AOC model not including growth and mortality. However, we do not fully agree with your assessment that the AOC model is more in line with the observed data. During the June and through September period the AOC model is computing about 1.2 mg C/L versus ST-SWEM's value of about 3 mg C/L. At a carbon to chlorophyll ratio of 30 mg C/mg Chl-a, the AOC would suggest a chlorophyll concentration of about 40 ug Chl/L, whereas the ST-SWEM would result in a value of 100 ug Chl/L. However, at a C:Chl value of 75, the AOC would result in a value of 16 ug Chl/L vs. 40 ug Chl/L for ST-SWEM based on the 1.2 mg C/L vs. 3 mg C/L estimated by the AOC and ST-SWEM, respectively. Therefore, it would appear that without knowing what the true carbon to chlorophyll ratio is, one cannot conclude what the corresponding concentration of carbon should be based on the chlorophyll-a data alone. Unfortunately, the available particulate organic carbon data are limited and do not provide an adequate data base with which to fully assess the validity of either model. It is more likely, that ST-SWEM over-estimates POC, while the AOC method under-estimates POC. Perhaps, expanding the analysis of the POC data, in a similar fashion as was performed by the CPG (LPR/NB Organic Carbon Screening Analysis - March 18-19, 2009 and the Proposal for eliminating the Eutrophication Model from the LRP/NB Modeling Work Plan, Memorandum - January 29, 2010) to include the POC data collected as part of the 2009/2010 PWCM field program may be useful.

In our initial discussions concerning the alternative organic carbon model approach, we both discussed the possibility that it might be appropriate to try and include some estimate of summer primary production for the alternative organic carbon model. It may be difficult to estimate what that primary production number should be without additional data and data analysis. However, it may be advisable, at some point in the future (i.e., once the CPG modeling team has performed some long-term contaminant fate and transport computations), to perform a sensitivity analysis of contaminant response to the differences in water column POC (and its impact on long-term sediment organic carbon content) for the June through September period as estimated by ST-SWEM versus the AOC.

With respect to Item m. (specified C-concentrations in the bed versus SWEM computed C-concentrations) of your memo, again the results are encouraging, but perhaps the model needs to be run for a greater period of time to make a true assessment of changes in bed concentrations computed by the two modeling methods, i.e., are there any implications of the AOC method under-estimating organic carbon in the lower estuary on long-term organic carbon in the sediment bed.

With respect to Item n. (mass balance differences), we would expect that the observed mass balance differences in the water column would be eliminated if RCATOX were to be modified to use the flux-corrected scheme. RCATOX could be coded to use the flux-corrected scheme for computing mass balances. While this would increase model run times, perhaps RCATOX could be coded so that the flux-corrected mass balance scheme is only executed for final production runs.

Given the information presented to date it would appear that the carbon simplification could be

implemented for the Lower Passaic River. However, if possible we would like to see a few more model vs. model computations. One would be a series of spatial plots of surface and bottom phytoplankton carbon and surface and bottom total organic carbon for all transects in the Lower Passaic River (IX=16, 17, 18 and 19) for a 10-day average in mid-July (when differences between the two models appear to be at a minimum), while the second would be a series of spatial plots of active layer total organic carbon at year's end for each transect in the Lower Passaic River (IX=16, 17, 18, and 19).

With respect to the particle mixing rate, we too have come to the conclusion that the model has too-high a particle mixing rate and agree that your proposed approach (or something very similar) is an appropriate way to proceed.

With respect to the computation of the archive layer thickness in ST-SWEM the following procedures are used:

1. Initial archive depths set by the sediment transport model, based on the concentrations of cohesives and non-cohesives and densities of the cohesive and the density of non-cohesives in archive layers as computed by ECOMSEDZLJS

$$HSEDAR(I,J) = CCOHAR(I,J)/DENS COH(I,J) + CNCOHAR(I,J)/DENS NCOH$$

Where

HSEDAR(I,J) = archive layer depth in grid cell (I,J),

CCOHAR = concentration of cohesives in the ECOMSEDZLJ archive (gm/cm2),

DENS COH = density of cohesives (gm/cm3),

CNCOHAR = concentration of non-cohesives in the ECOMSEDZLJ archive (gm/cm2),

DENS NCOH = density of the non-cohesives (gm/cm3), (a constant)

Note: there is no deep bed computation in ST-SWEM, it is included only in RCATOX

2. Then at each time-step in ST-SWEM, based on cohesive deposition fluxes (settling rates times water column concentrations) and resuspension fluxes (flux averaged over 15 minute intervals) and net non-cohesive fluxes (resuspension flux – resuspension flux averaged over 15 minutes) as computed in ECOMSEDZLJS, ST-SWEM can compute change in the depth of the active layer as follows:

C Cohesive Deposition

$$MASSDEPCOH = VSCOH*CCOHWC*DELTAT$$

C Change in depth due to cohesives

$$DELTHC = MASSDEPCOH/COHDENSITY - RESFLXCOH*DELTAT/DENS COH$$

C Change in depth due to non-cohesives

$$DELTHNC = -NETFLXNCOH*DELTAT/DENS NCOH$$

C total bed elevation change / total bed depth

$$DELTH = DELTHC + DELTHNC$$

$$HTOT = HSEDTM1 + HSEDATM1 + DELTH$$

C Compute new active layer thickness

$$HDELTH = HSEDTM1 + DELTH$$

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C      If maximum depth of active layer > hsedmax => burial
      IF(HDELTH.GT.MAXHSED) THEN  ! Burial
      Cohesive and non-cohesive mass determined based on HDELTH – MAXHSED
      Taken from active layer and moved in archive layer
C      If minimum depth of active layer < hsedmin => erosion
      IF(HDELTH.LT.MINHSED) THEN  ! Erosion
      Cohesive and non-cohesive mass determined based on HDELTH - MINHSED
      Taken from archive layer and moved inactive layer

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where

CCOHWC = concentration of cohesives in the water column (gm/m³)

VSCOH = deposition velocity (m/day)

RESFLXCOH = resuspension flux of cohesives (gm/m²-day)

NETFLXNCOH = net (resuspension – deposition) flux of non-cohesives (gm/m²-day)

HSED and HSEDTM1 are active layer depths at current (T) and previous (T minus 1) time levels

HSEDA and HSEDATM1 are archive layer depths at current (T) and previous (T minus 1) time levels

MAXHSED = maximum active layer depth = 10.1 cm

MINHSED = minimum active layer depth = 9.9 cm

Subroutine **HSEDS** is where all of the computations are performed. The above is a slight simplification of the code. There are a number of checks that are performed in HSEDS to make sure that the total bed depth is not completely eroded as well as stability checks to make sure that the carbon model does not go unstable in a time-step.

3. A similar process for computing bed elevation changes is followed in RCATOX, except that in RCATOX, the active layer (~10 cm) is divided into 10 1cm slices and the archive layer is initially set at 97 1 cm slices – this permits us to represent the top 3.5 feet of the sediment bed and to assign initial conditions consistent with core slicing. RCATOX also has an initial deep bed layer that is 2 feet (61 cm) allowing the model to represent the top 5.5 feet of the sediment bed. The deep bed is assumed to be completely mixed. The difference between ST-SWEM and RCATOX is that ST-SWEM determines burial and erosion based on the active layer depth exceeding 10.1 cm or going less than 9.9 cm, whereas in RCATOX, burial occurs if the surface layer (layer 1) of the “active layer” (top 10 cm, wherein particle mixing occurs) exceeds 2 cm. If that occurs, then the surface layer is split into two 1 cm slices with one of the new 1 cm slices becoming layer 2 and the stack is pushed down with the bottom of the archive stack being pushed into the deep bed. If the surface layer becomes less than 0.5 cm, then layers 1 and 2 are combined and the new ~1.5 cm slice is layer 1 and layer 3 is pushed up to become layer 2 and the entire stack is pushed up, with 1 cm of the deep bed being moved into layer

97 (the bottom) of the archive layer stack and the deep bed being reduced 1 cm in thickness.